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# THE STUDY OF THE ROLE OF WORKING MEMORY IN THE TEACHING OF TEXT-BASED PROBLEMS

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**Abstract:** In this article, we will present the first results of a class experiment regarding text-based problems. The 6th-grade students from the experiment met the teaching of text-based problems for the first time. The main aim of the experiment was the diagnosis and possible remedy of the problems with working memory. As to the problems encountered during the teaching experiment, we will analyze the comparative results of the pre-test and the post-test, then will draw some conclusions for the teaching practice.

**Key words:** didactcs of mathematics, text-based problems, working memory.

## 1. Introduction

The ancient Babylonians already solved text-based problems. Though the texts of the problems and their results have been preserved on clayboards, the course of solving the problems remained so much the less. The first piece of work of Mathematics in Hungarian, *The Arithmetic of Debrecen*, also contains text-based problems: *"How big is a group of friends if we know that, if they were twice and a half as many, they would 30?"* [9]

The difficulty of solving text-based problems stays in their interpretation and understanding. Children "are cable of carrying out exactly the arithmetic and algebraic operations, but their representational abilities are not adequate." [10] An 8th-grade student described the difficulty of understanding a text-based problem as follows: *"By the time I reach the middle of the text, I forget what the first part was about."* [1]

## 2. Research

### Theoretical foundations

The base of a problem is found in the construction and working of the brain. The part of the human brain which contains everything that we are thinking of in a certain moment is the working memory. The working memory stores and processes the information, but its capacity is limited, as it can store 7±2 units for as long as only 15-20 seconds. According to Baddeley, the working memory consists of four parts [2](see Figure 1)

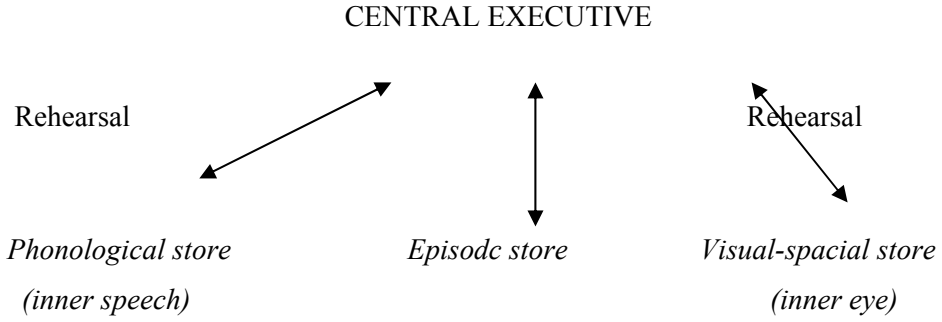


**Figure 1.** Working memory

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The phonological store contains speech-like information, while the visual-spacial store contains image-like information. These two suunits can operate simultaneously as well. The central regulator controls and works. The episodic store connects the central regulator and long-term memory. [3]

## The possible solutions to the problems

Because the working memory can only store a few units for a short time, considerable difficulties are generated in the course of solving text-based problems by keeping in mind, then recalling the data of the problem, and finding the connections between these data. The capacity of the working memory can be increased through the parallel operation of the phonological and the visual stores. Thus we make a diagram beside the text of the problem. This is the so-called multiple encoding.

"Most of the learners are not able to apply the basic mathematical principles in a new situation until they see a step-by-step manner of solving shown by the teacher. These learners need to be given the possibility to apply the steps presented by the teacher in a new problem situation." [6] This is one way to increase the capacity of the working memory, as certain processes become automatized through solving of problems repeatedly.

## Mathematical text-based problems

"The mathematical text-based problems comprise all such problems whose formulation is done by text, and whose solving needs the use of a certain area of Mathematics." [4]

The solving of text-based problems consists of several steps:

1. Understanding of the problem
2. Extracting and organization of the data
3. Analyzing the problem: differentiating between important and negligible data
4. Making a solving plan
5. Carrying out the solving plan
6. Verifying of the solution, comparing it with the hypotheses and with reality. [8]

The first of the steps of solving text-based problems already causes much difficulties to those students who have troubles with reading or text comprehension. These learners are functional illiterates. Functional illiterates are those persons who have learnt to read and write, can read short texts, but cannot understand longer texts. [7]

Before analysing the solving of mathematical text-based problems in a class of children, it is worth measuring their ability to read and understand texts.

## The experiment

The scene of the experiment is the lower-secondary school from Diosig, a large village in Romania. The class taking part in the experiment is class 6B, one of the two 6th-grade classes where the teaching is done in Hungarian. This class has 21 students, of which 16 are of Hungarian mother tongue and 5 come from gipsey families who speak the gipsey language. Of the 21 students, 3 attend the 6th grade for the second time because they failed to pass in one or two subjects in the previous year. The class is of mediocre learning ability.

The experiment took place during 14 teaching hours between 2011, November 14th and 2011, December 16th.

## The aims of the experiment:

1. The analysis of the students' ability to understand texts
2. The analysis of the relevant and irrelevant data from the perspective of the problem
3. The use of instruments enhancing memory

## The topics of the lessons during the experiment

- Reading comprehension test
- Pre-test
- How do we solve the problemst?
- What is the question?
- Analyze the data
- Make deductions backwards
- Make a diagram
- Keep a balance
- Verify the solution
- Answer the question
- The steps of solving problems
- Post-test

## The course of the experiment

The experiment began with a reading comprehension test. The students were given a fragment from a folk-tale entitled *The Fox Gives out Cheese* [11], which they had to read individually. Then they had to answer some questions: Who are the charactes? What is the conclusion of the story? What other title could be given to the story? After that, they had to put some sentences in order, look for certain words in the text, and insert other wordsin it. The assessment of the reading comprehension test is the following see Tabel 1.

**Tabel. 1** The assessment of the reading

| | Insufficient | Sufficient | Good | Very good |
|---|---|---|---|---|
| Number of students | 0 | 5 | 7 | 9 |

After the test, the students read the text aloud. Of the 21 learners, 9 have reading difficulties and cannot read fluently a short and simple text. Because of these students having reading difficulties, much attention had to be paid to give them not only written texts during the experiment, because we would have not be able to observe how the poor readers think, these children getting stuck with the reading of the text.

The reading comprehension test was followed by the pre-test:

## Pre-test

1. *Which is the natural number that:*

   *increased 3 times makes 18*

   *increased by 3 makes 18*

   *decreased by 3 makes 18*

   *decreased 3 time makes 18?*

2. *The total age of the mother, father and the three children is 99. The father is 13 times as old and the mother is 12 times as old as Nórika. Csaba is twice as old and Lilla is five times as old as Nóri. How old are the members of the family?*

3. *During their trip to Paris, Réka and Árpi took lots of pictures. On Wednesday, they took half the photos at the Eiffel Tower, two thirds of the rest at the Notre Dame, and the remaining 8 at the Arch of Triumph. How many pictures did they take on Wednesday?*

4. *When Mark was born, his father was 5 years older than his mother. Mark is now 12 years old, and his mother is 37. What is the age difference between his parents? [5]*

All the studentswere given the text of te pre-test, they had 40 minutes to solve the problems. They could decide upon the order or manner of solving the problems as they wished.

When the pre-test was administrated, there were **five** students who could not solve any of the problems. These were the same the children who scored sufficient in the reading comprehension test. There were **six** students who solved one or two subpoints of the first problem correctly. **Three** of them solve every subpoint of the first problem correctly but could not cope with the other problems. Some of them listed the data of the problem but could not make a solving plan and solve the problem. All together, there were 14 students who solved none of the text-based problems. Only six students successfully began to solve some of the text-based problems, too.The results of the post-test in Tabel 2.

**Tabel. 2** Results of the pre-test (**4** is the least goog score, **10** is the best score)

| Score | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
|---|---|---|---|---|---|---|---|
| Number of students | 5 | 6 | 3 | 5 | 2 | 0 | 0 |

During the 11 lessons following the tests, the students learnt the steps of solving text-based problems. Some of the problems were given to them in written form, others could be read on a projector, others were read by the teacher. Here are some of the problems dealt with during these lessons:

*1. Géza is now 11 year old, 156 cm tall and wighs 42 kg. His friend Bálint wighs 45 ks and is 158 cm tall. Who is the tallest and by how much?Put down the data that are necessary to answer the question. Put down the data that are useless for answering the question. [5]*

This problem was given out in **printed** form, then was solved individually. Out of the 21 students, **14** did not manage to select the **necessary** and **useless** information for answering the question. **7** students performed this task, and all of them solved the problem. **7** students could not solve the problem, they only listed the data again but did not calculate anything, except for two students.Both of them considered all the data to be necessary. P.N. addedtogether all of Géza's data: "11+156+42=129", and Bálint's too: "45+158=203", then answered the question: "Géza is 6 cm taller than Bálint".

*2. From an ants' nest, 25 ants scattered in all directions. Four ants found 20 crumbs on a terrace. Each ant carried 3 crumbs at least or 6 at most. How many crumbs did the ant that got the least of the 20 crumbs carry, if two of the four ants carried 5-5 crumbs?Is there any useless information? [5]*

This problem was **projected**. The 7 students who could not solve the previous problem did not manage this time either. Several of them put down some data or copied the problem without solving it. **7** students found some useless information, **6** students solved the problem correctley, but only three of them put down the useless data.

*3. Santa Claus bought 200 identical Christmas packets. How much did he pay for all the packets?What information is missing so as to solve the problem? [5]*

The teacher **read the problem aloud** twice!

**5** students could not solve the problem, and the others gave a good answer. Two of them also extanded the answer:

P.H.:"The missing information is how much one packet is.

One packet is around 2 lej. 400lej.

200·2=400"

K.B.:"This problem is lacking the price of half of the 200 packets, or at least one packet."

*4. Two cars set out from Oradea and Cluj-Napoca one towards the other on route E60 at the same time. One of cars goes one and a half times faster than the other. They meet after 70 minutes. Which car is the farthest to Oradea at this point? [5]*

None of the students answered correctly. The teacher asked everyone to draw the position of the two cars at the beginning and at their meeting point. Having the drawing, the students were able to give the correct answer. The visual representation made the solving of the problem easier later as well.

The experiment ended with the post-test.

**Post-test:**

*1.Pisti, Ildikó and Zolika picked some nuts. When they finished, they counted the nuts. They found out that Zolika picked 3 times less nuts than Ildikó did, whereas pisti picked 5 times more nuts than Zolika did. In all, they gathered 171 nuts. How many nuts did each of the children pick?*

*2. A swarm of bees flew into our couryard. Half of the bees settled in te apricot-tree, two thirds of the rest settled on the goldenrod, and the remaining 18 bees flew on the tulips. How many bees flew into our courtyard?*

*3. A puppet maker make three kinds of puppets: lions, tiger and monkeys. He uses as much material for making 2 tigers as for making 8 monkeys. For making 1 tiger and 2 monkeys he needs as much materail as for making 2 lions. How many times as much material does 1 lion need as 1 monkey?*

*4. King Burkus gave out his 18 castles to his sons so that each of his sons received as many castles as the twofold of the number of the sons. How many castles did the king have?*

The post-test was written by 20 students. The results of the post-test in Tabel 3.

**Tabel. 3** Results of the post-test (**4** is the least goog score, **10** is the best score)

| Score | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
|---|---|---|---|---|---|---|---|
| Number of students | 2 | 5 | 4 | 5 | 2 | 0 | 2 |

The first problem was solved correctly by 4 students. All of them drew a sketch for the problem: one student used segments, three of them used rectangles.

The second problem was solved by 6 students. 5 of them put down a sketch and gave the answer, one student only wrote the answer (we do not know where he/she made the calculations). Only 4 students did not try to make a representation. **In the pre-test, no one solved the similar problem.**

The third problem was solved by 5 students. They either used the initial letter of the animals or drew them. Two other students began to solve the problem but made some mistakes, and the result was not correct.

As to the fourth problem, 10 students gave a correct answer. Two of them made some calculations and the result was the answer. One student could not solve the problem. Later, during a conversation, the teacher asked him/her to read the problem aloud. His/her reading was very poor, but by the time he/she reached at the end, he/she already knew the solution. Two students answered how many sons the king had, one said how many castles he gave to each of his sons. Now again, some of the students just guessed. **In the pre-test, 5 students gave a correct answer to the similar question.**

Comparing the results of the pre-test and the post-test, we can observe the following. While in the pre-test the beggest score was 8, there were two totally correct paperst in the post-test, so their score was 10. Only 2 of those 5 students who did not write anything in the pre-test were not able to start working on any problem.

Summarizing, the students who improved thir previous resultswere active during the lessons, took into consideration and followed the teacher's instructions during the individual work, tried to understand the text of the problem and did not pay attention only to the numbers, and had a good reading comprehension.

## 3. Conclusion

There are important differences between as few as 21 students, too.We consider that the reason for the existence of high-level groups stands in Mathematics. It is for the near future to come up with a

developing plan for the students with working memory os little capacity. In the first place, they need to solve text-based problems thatlack unnecessary information. The question of necessary and useless datahas to be analyzed and practiced separately with them. The texts should be related to familiar occurrences (the episodic memory).

Great consideration must be given to the automatism of the operations, so that the capacity of the working memory could be relieved.

The concrete, material an visual representations are of great help in finding the model of the problems (the use of segments in the representation of quantities and their relation).

The conditions of learning success are intelligence, motivation, attention, diligence, relating the new material to those which the students heve learnt, the processing of the new material, revisions.

Dr Spencer Kagan's thoughts sum up what is wporth omplying in the course of teaching Mathematics:

***"The more ways we teach, the more people we reach***

***And, the more ways we reach each***

***And, the more deeply what we teach will reach."***[12]

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